

Are Areas Hit Hard by Pandemic H1N1 in the Spring Seeing Elevated Activity in the Fall?

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Objective

- Evaluate local jurisdictions during the spring and fall waves of the 2009 H1N1 pandemic
- Determine if areas that had extensive influenza activity during the spring wave also had extensive activity in the fall



Background

- After the spring wave of the H1N1 pandemic, we wondered whether or not areas affected during the spring would be affected again during the fall

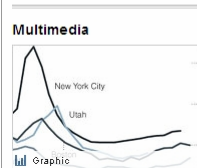
– NY Times article:

- Areas with large outbreaks in the spring (i.e. New York City) are not seeing activity in the fall
- Concept of herd immunity

Areas Hit Hard by Flu in Spring See Little Now

By ANEMONA HARTOCCOLLIS and DONALD G. McNEIL Jr.
Published: October 8, 2009

While concern over the spread of the H1N1 virus sweeps the country, epidemiologists in New York and a few other cities that were awash in [swine flu](#) last spring are detecting very little evidence of a resurgence.



Although [flu](#) season will not peak until the weather gets cold, in New York, which was the nation's hardest-hit city, officials say that flu activity is no higher than it normally is at this time of year and that school attendance is normal.



ILINet Background

- Collaboration between CDC, state health departments, and primary health care providers
- ~3,300 healthcare providers in all 50 states, Chicago, NYC, Virgin Islands and DC are enrolled in the system
- Weekly reports
 - Total # patient visits
 - # visits for influenza-like illness (ILI) by age group
 - ILI = fever $\geq 100^{\circ}\text{F}$ ($\geq 37.8^{\circ}\text{C}$), oral or equivalent, and cough and/or sore throat, in absence of a known cause



CBSA Statistic

- Weekly ILI data are collected by ILINet
- Baseline ILI ratios for each provider are calculated
- LOCAL AREA= Core Based Statistical Area
 - “The United States Office of Management and Budget (OMB) defines metropolitan and micropolitan statistical areas according to published standards that are applied to Census Bureau data. The general concept of a metropolitan or micropolitan statistical area is that of a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core.”
<http://www.census.gov/population/www/metroareas/aboutmetro.html>
- The baseline ratio for a CBSA is the weighted sum of the baseline ratios for the providers within the CBSA

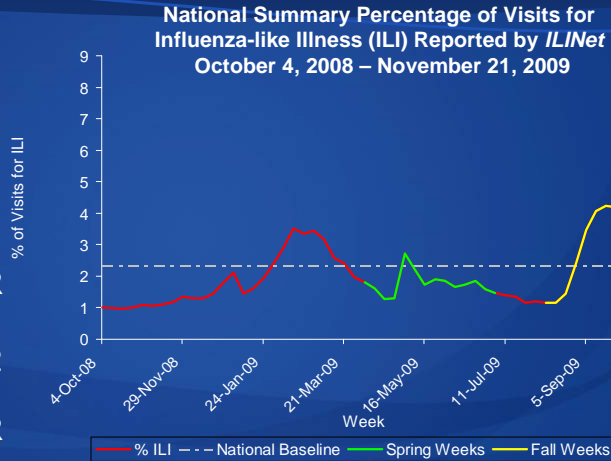


CBSA Threshold Movie



Time Periods

- Defined time periods for Spring and Fall intervals
 - Spring March 29 - July 4, 2009 (MMWR weeks 13-26)
 - Fall: August 2 – October 3, 2009 (MMWR weeks 31-39)



Methods

- The numbers of standard deviations above each CBSA specific baseline mean were calculated for each week during the specified time period.
- CBSAs whose ILI ratios were determined to be three standard deviations above their baseline mean for 2 consecutive weeks during the spring and/or fall period were identified
 - These CBSAs classified as having had an outbreak during the given time period
- The number of CBSAs with outbreaks was tabulated for both intervals.
- Using CBSA spring outbreak as group exposure, we computed the ratio of the odds of a fall outbreak with and without this exposure
 - Odds ratio using ecologic data, not an individual based exposure.



Methods

- Different spring/fall interval definitions as well as outbreak definitions were also evaluated
 - ILI activity 1, 2, 3, or 4 std dev above the baseline mean
 - Min number of weeks above the specified threshold: 1, 2, 3 or 4
- Also restricted to 50 most populous CBSAs and states



Results

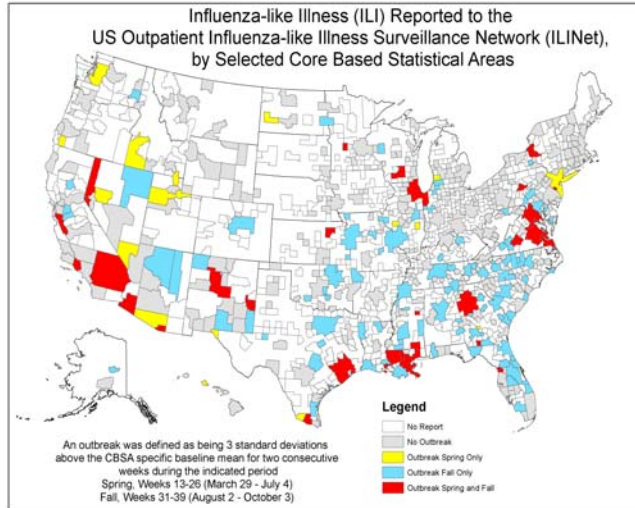
- Outbreak:
 - SDs above baseline: 3
 - Weeks above thresh: 2

	Spring only	Fall only	Both	Neither
#CBSA with outbreak	17	101	33	282

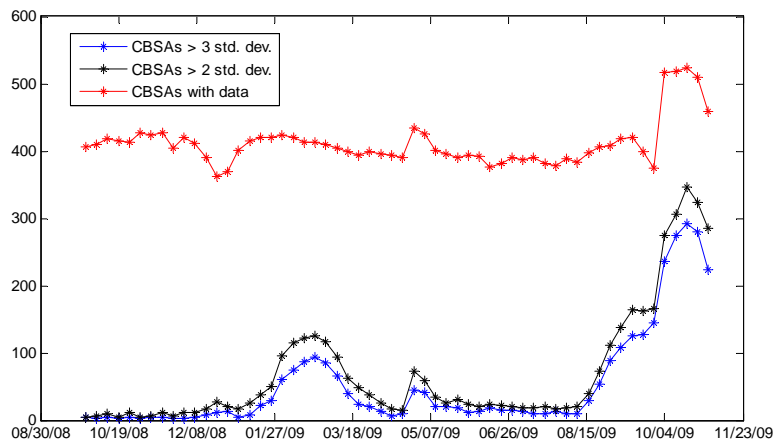
– OR= 5.4 (2.9-10.2)



Results



Results



Results

Spring Weeks	Fall Weeks	Threshold	Number week above threshold	Odds Ratio (95%CI)	Fall and Spring Outbreak	Spring Only Outbreak	Fall Only Outbreak	No Outbreak
13-26	31-39	2	3	4.52 (2.27-9.01)	23	15	100	295
13-26	31-39	2	4	4.83 (2.18-10.71)	14	13	74	332
13-26	31-39	3	3	5.22 (2.28-11.93)	14	11	80	328
13-26	31-39	4	2	4.74 (2.29-9.84)	19	14	89	311
17-26	31-39	2	3	4.57 (2.14-9.73)	19	12	103	297
17-26	31-39	2	4	5.34 (2.23-12.83)	12	10	75	334
17-26	31-39	3	2	5.73 (2.97-11.06)	31	15	102	283
17-26	31-39	3	3	5.42 (2.21-13.29)	12	9	81	329
17-26	31-39	4	2	4.91 (2.26-10.66)	17	12	90	312
17-26	31-42	2	3	4.45 (1.89-10.52)	25	7	190	237
17-26	31-42	3	2	8.99 (3.49-23.18)	42	5	199	213
17-26	31-42	3	3	2.91 (1.20-7.09)	14	8	164	273
17-26	31-42	3	4	3.12 (1.07-9.10)	7	7	108	337
17-26	31-42	4	2	5.33 (2.13-13.30)	24	6	184	245



Conclusions

- Areas that experienced high levels of influenza activity in the fall were more likely to have experienced high levels of activity in the spring
 - School age children important in transmission in the community
 - % of population infected may not be high enough to infer herd immunity
- This knowledge can inform future preparedness and vaccine program planning activities.
- The linkage between spring and fall H1N1 incidence should be evaluated using a finer level of spatial resolution
 - influenza outbreaks are so focal and neighborhood-specific that spring and fall outbreaks could represent separate events.



Backup Slides



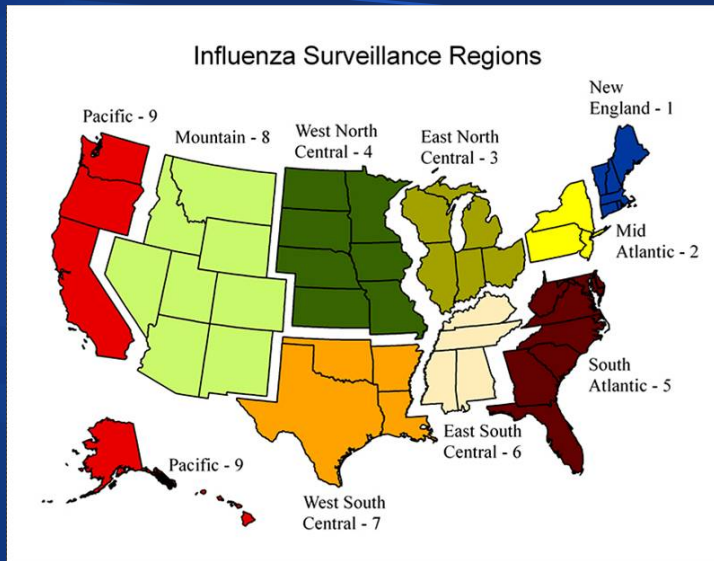
Background

CDC ILINet collects data each week from sentinel care providers across the United States.

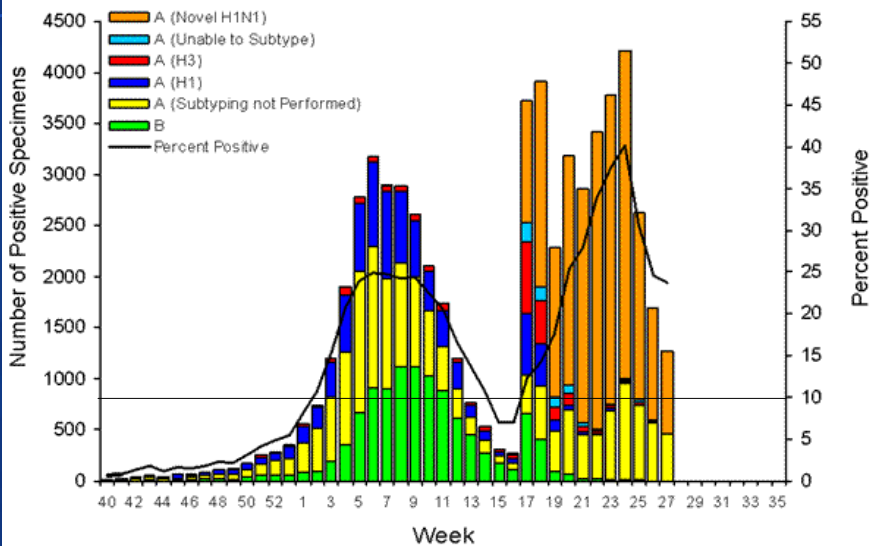
- Over 2,700 providers from all 50 states during the 2008-09 influenza season.
- Each week, providers report total nr. patient visits & nr. ILI-related visits by age group.
- About 60% of providers send data every week, some intermittently
- Provider base generally expanding with occasional dropouts.
- A provider may be a physician practice, a health center, or as large as a group of hospital emergency departments.
- Previous aggregation into 9 census regions for analysis and presentation.
- Requirement: allow stable weekly surveillance at the level of core-based statistical areas (CBSAs) while adjusting for small-scale variability.



Census Regions for Baseline Calculations



Influenza Positive Tests Reported to CDC by U.S. WHO/NREVSS Collaborating Laboratories, National Summary, 2008-09



Region-Based Method

Statistic used for regional surveillance has been:

$(\text{observed ILI ratio} - \text{baseline ILI ratio}) / (\text{baseline std. dev.})$

- Observed ILI ratio: current week's nr. ILI cases / total nr. visits.
- Baseline ILI ratio: same ratio over those weeks in the past 3 years for which fewer than 10% of influenza lab tests had positive results for region of interest.
- Anomalies presented as nr. standard deviations above baseline mean without assuming a fixed probability distribution.



Provider-Adjusted Statistic, I

Statistic = $(\text{Weekly CBSA Ratio} - \text{CBSA baseline ratio}) / (\text{CBSA standard error})$

Weekly CBSA ratio: $(\sum \text{ili counts} / \sum \text{all visits})$ for all CBSA providers

Computation of baseline ratio:

- CBSA baseline ratio: weighted sum of baseline ratios of currently participating providers
- Weighting according to the total nr. current visits reported
- Provider baseline ratios:
 - For “trusted” providers: ILI counts / visits for regional baseline weeks, ignoring weeks with no ILI reports
 - For remaining (new, sporadic) providers: mean of baseline ratios for trusted providers of the same type



Provider-Adjusted Statistic, II

- CBSA “standard error”: using normal approx. to binomial distribution: $\text{sqrt} (\text{ratio}) * (1\text{-ratio}) / (N\text{=total visits})$
 - Requires higher ratios for smaller CBSAs
 - Modified for very large CBSAs: $N = \text{minimum of (total weekly visits) and round}((3.0^2) * \text{ratio} * (1\text{-ratio}) / (0.01^2))$,
 - so that a 3.0-standard error anomaly requires at least a 1% increase above expected

ili	visits	p	p0	expected ili	stat	modified	modified stat
182	13646	0.013	0.010	136	3.40	1184	1.00
	p-p0 threshold						
	0.01	3					



Provider-Adjusted Model Details

Trusted provider conditions:

- at least 10 wks with total visits > 0 in last flu year AND
- at least 10 wks with ili counts > 0 in baseline weeks (flu pos. rate < 10% for the region of that provider)

Reduce the set of provider types to be sure that there are sufficient trusted providers in each type. 6 reduced types:

- 1 'Emergency Medicine'
- 2 'Family Practice', 'Infectious Disease'
- 3 'Internal Medicine', 'OB/GYN', 'Other'
- 4 'Pediatrician'
- 5 'Student Health'
- 6 'Urgent Care'

- Need updated table for all known providers:

provider ID, provider type, cbsa ID, state, census region, HHS region



Provider Type Baseline Statistics

Provider Type	Nr. Providers	Baseline mean	Baseline Std. Dev.
Pediatrics	519	0.0263	0.0315
Emergency Medicine	308	0.0201	0.0129
Urgent Care	143	0.0153	0.0097
Community Health	14	0.0167	0.0125
Family Practice	1299	0.0084	0.0121
Infectious Disease	44	0.0088	0.0075
Internal Medicine	276	0.0042	0.0079
OB/GYN	3	NaN	NaN
Other	242	0.0048	0.0094
Rural Health	1	NaN	NaN
Student Health	239	0.0049	0.0085

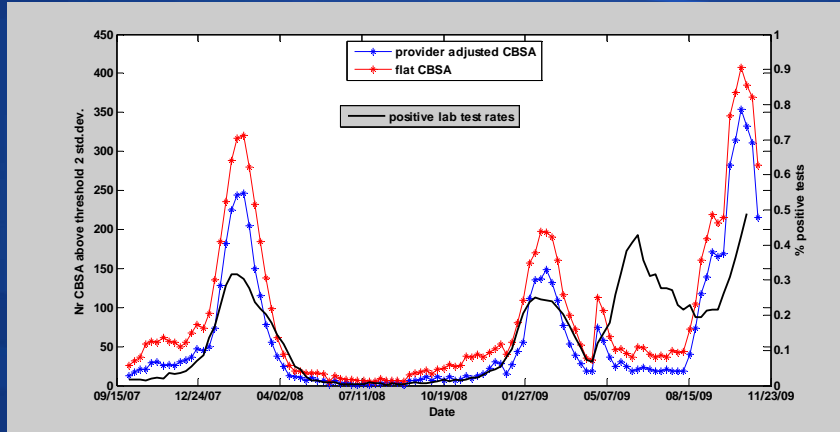


Example

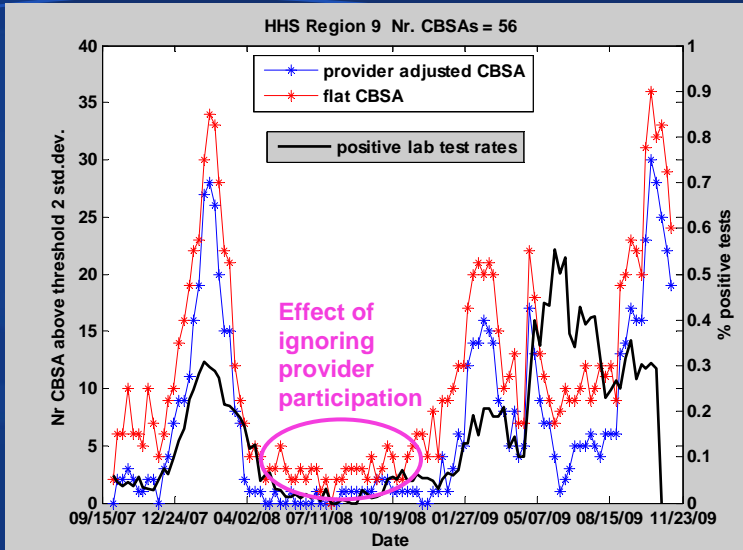
- CBSA has 2 providers: pediatric, community clinic
 - Mean rate from pediatric provider: 0.025
 - Mean rate from community provider: 0.010
- 1000 cases from pediatric provider, 300 cases from community provider
- Expected rate for cbsa, this week:
 - Exp. rate = $(1000 (0.025) + 300 (0.010)) / 1300$
 - For poorly represented providers, use mean and std. dev. for provider type



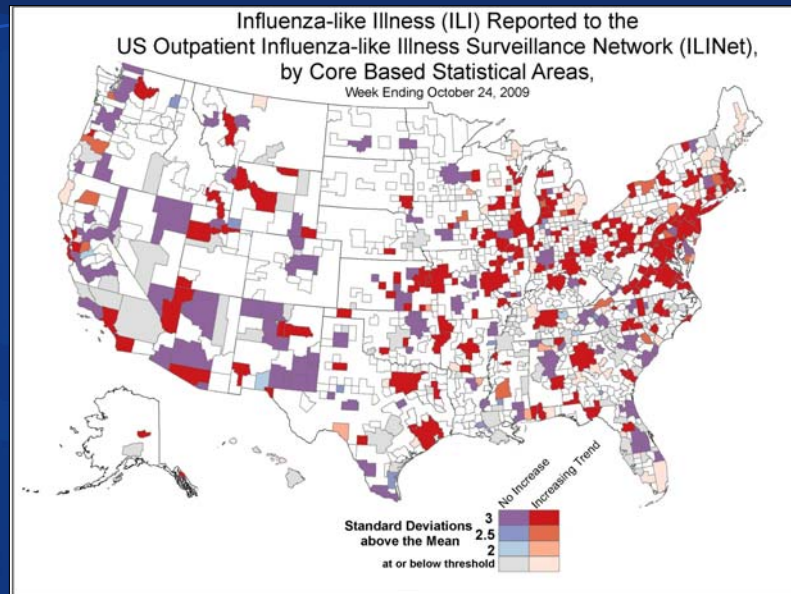
Effect of Provider Adjustment



Regional Adjustment Effect



Sample Bivariate Color Map: Level & Trend



Conclusions and Future Steps

- The provider adjustment gives a representative picture of weekly ILI activity below regional spatial resolution, given available provider information
- Currently applied at state and CBSA levels
- High provider-level fluctuations during fall portion of pandemic, as predicted; anecdotal validation
- Working on estimation of age group totals to stratify analysis by age group
- Related analyses: effect of local spring H1N1 activity on fall disease burden

